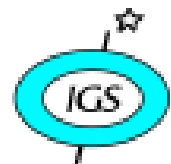# Multi-GNSS within the IAG/IGS

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International Association of Geodesy (IAG)
International GNSS Service (IGS)

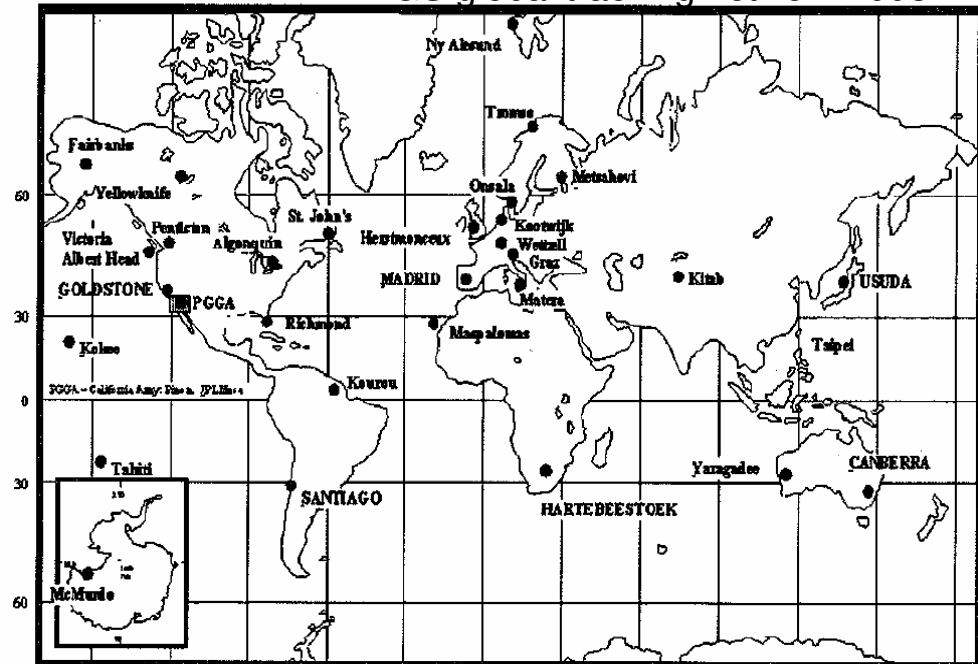ICG-6 Meeting, Tokyo, Japan, 4-9 September 2011

IAG, GGOS & IGS

- The International Association of Geodesy (IAG) represents the geosciences associated with the **geometric** & **gravimetric** aspects of the dynamic Earth.

- IAG is part of IUGG (& ICSU). The oldest of the international scientfic associations… *150yrs old in 2012*.

- IAG's Global Geodetic Observing System (GGOS) integrates all IGS Services… *to coordinate geodetic measurements, analysis and product generation to support science and society*.

- The IAG's International GNSS Service (IGS) is a component of GGOS.

- The IGS coordinates GNSS tracking, data analysis and product generation to support GGOS and other users.

- Key to approach: sharing investments and operational costs by pooling the resources of many (> 200) organisations to maintain an independent ground tracking network and generate high accuracy products … ***voluntary federation, reliability through redundancy, data & products freely available to all users***.
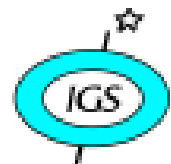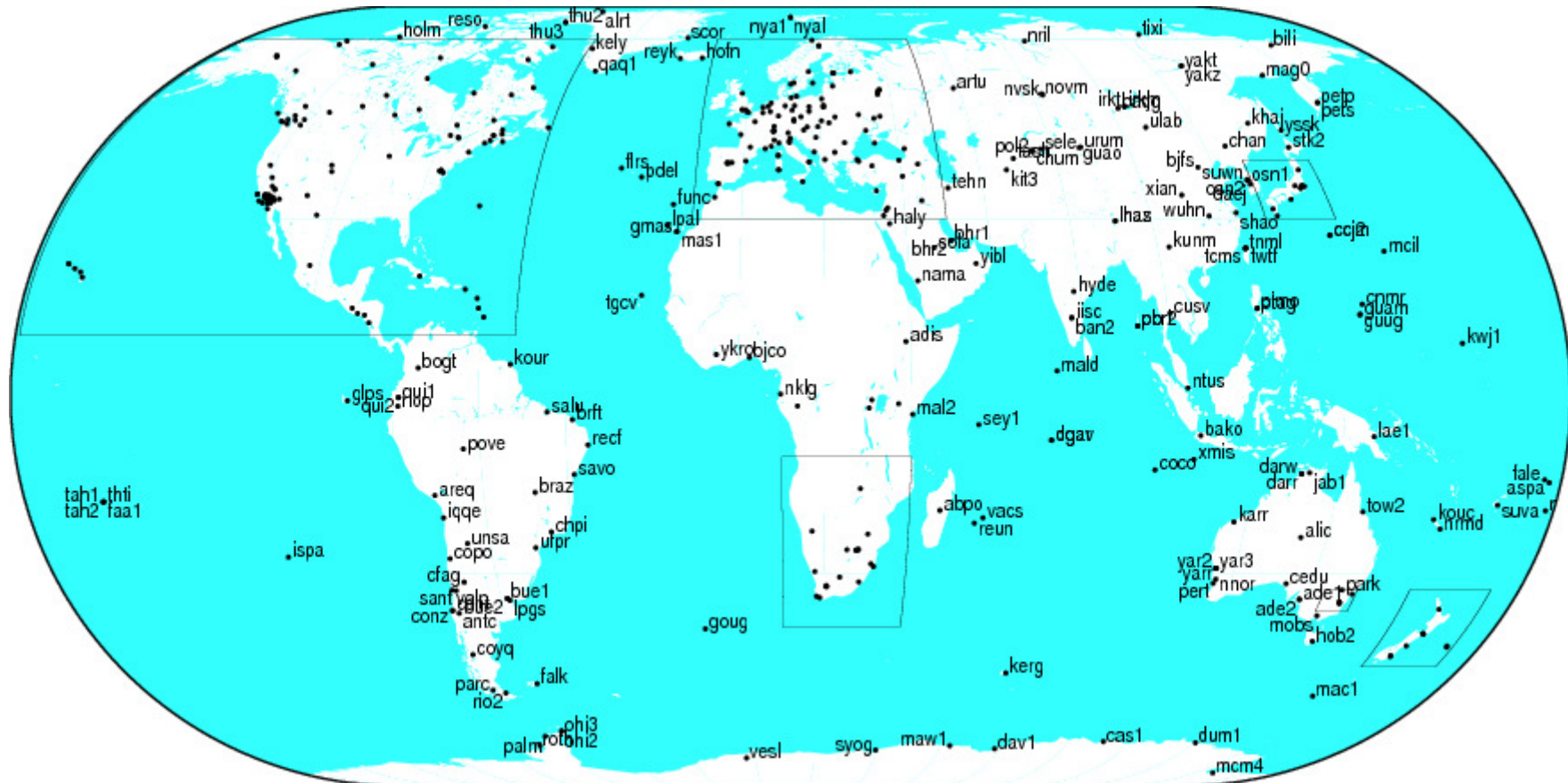
International GNSS Service (IGS)

- Potential of GPS for Geodesy and Geodynamics was recognised in the late 1980's.

- Start of IGS Test Campaign in June 1992. *Official Service of the IAG since 1994*.

- Renamed "International GNSS Service" in March 2005. *Part of GGOS*.

- Products:

  - orbits

  - clock corrections

  - Earth orientation parameters

  - station positions and velocities

  - troposphere parameters

  - ionosphere maps

- GPS and GLONASS tracking & products.

IGS global tracking network 1993

IGS Tracking Network
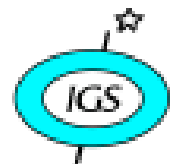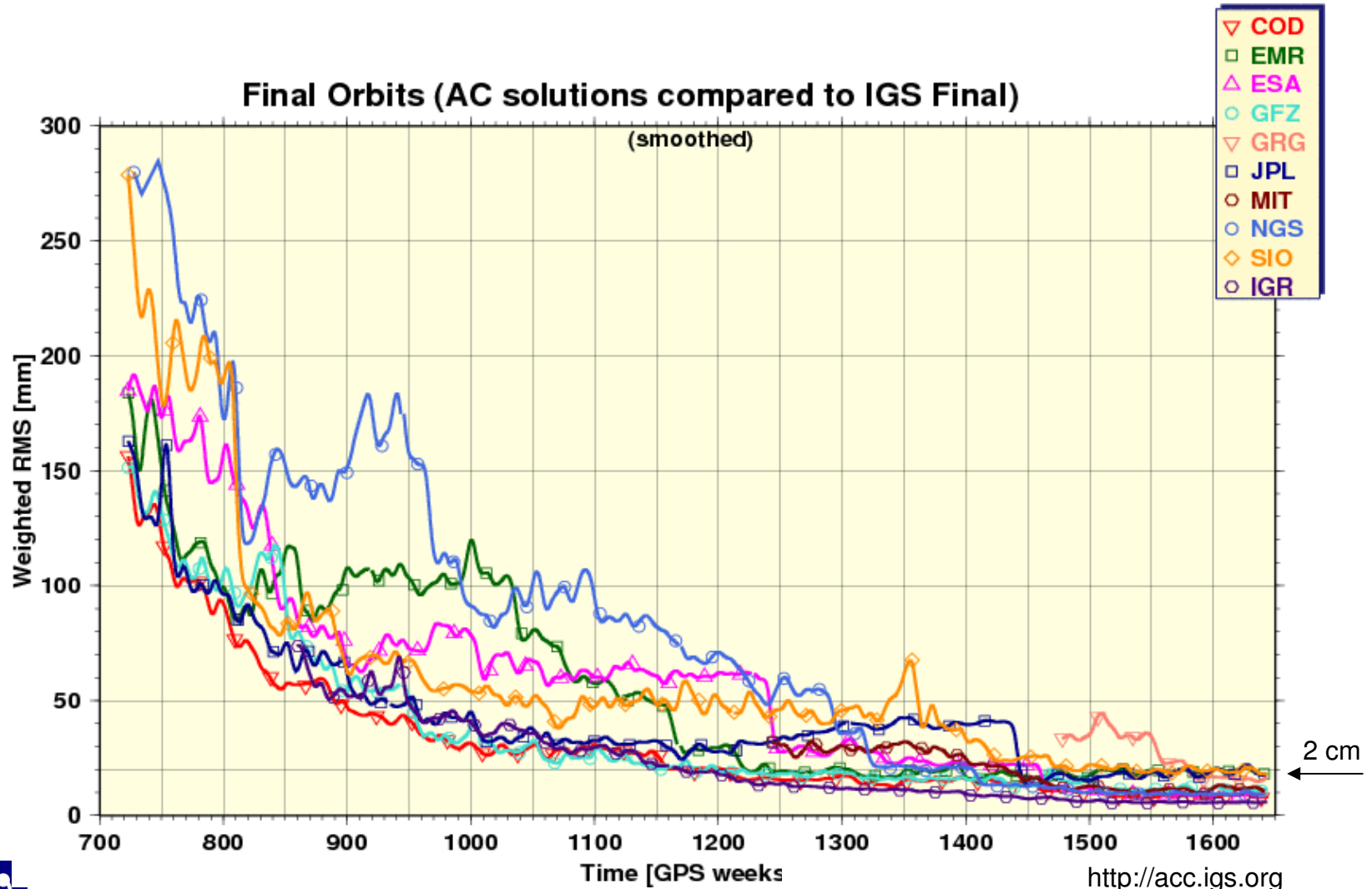
- Over 380 active global tracking stations

IGS Orbits

Final Orbits (AC solutions compared to IGS Final)

(smoothed)

Legend: COD, EMR, ESA, GFZ, GRG, JPL, MIT, NGS, SIO, IGR

Weighted RMS [mm]

Time [GPS weeks]

2 cm

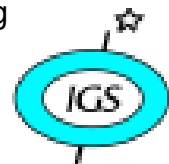http://acc.igs.org

IGS Ultra Rapid Orbits

IGS Ultra Rapid Orbits (24h predictions compared to IGS Rapid)
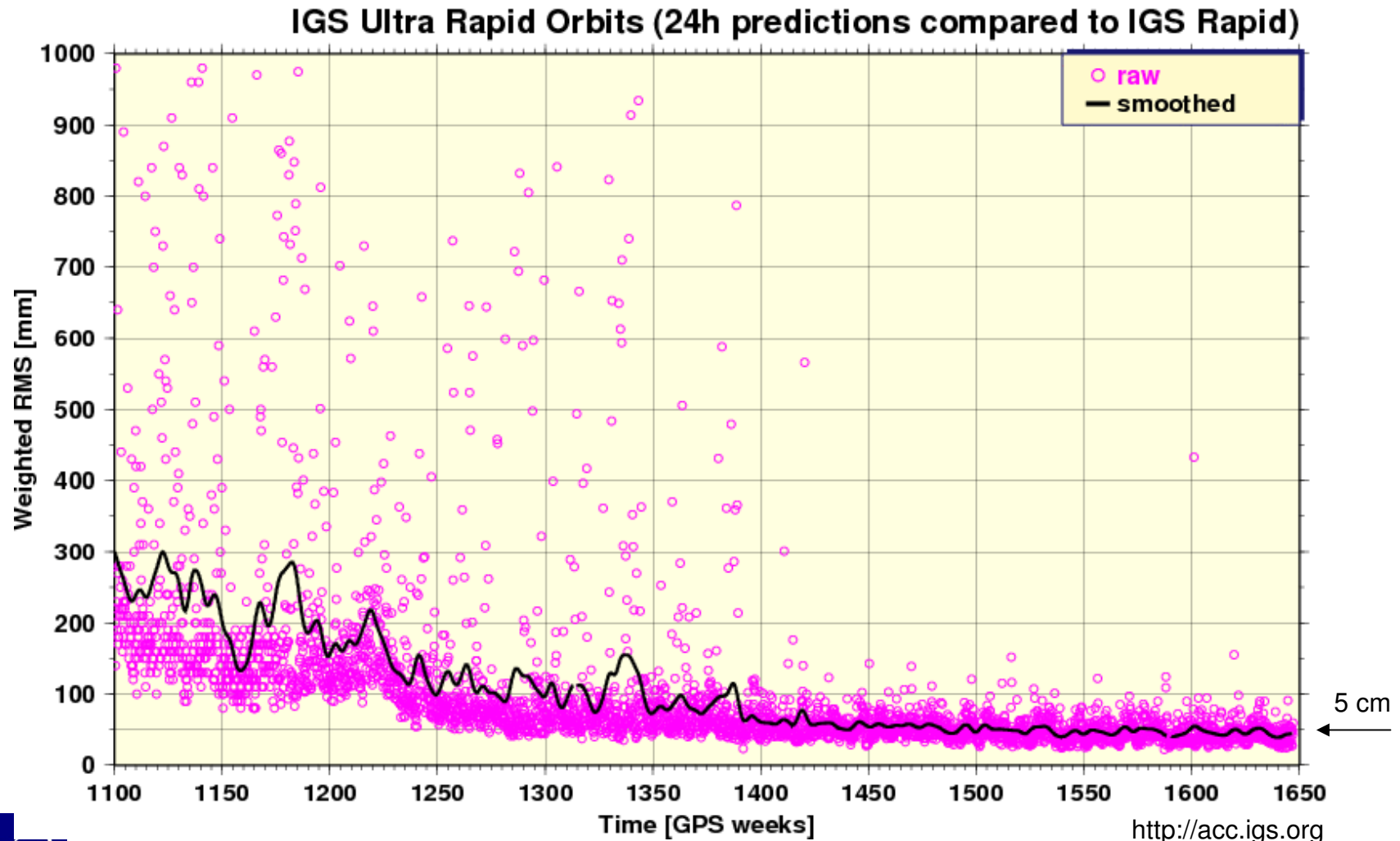
ICG-6 meeting is GPS Wk 1652

http://acc.igs.org

Real-Time Pilot Project

- Real-time product generation is part of IGS Strategic Plan.
- Infrastructure:
  - More than 120 active real-time stations… *see map*
  - Data streaming using NTRIP
  - Close link to RTCM… *standard RT data/product formats for users*
- Analysis:
  - 6 real-time analysis centres
  - Real-time orbit & clock computations
- Future:
  - Real-time service to commence in 2013
  - Include new systems and signals in analysis
  - Expand IGS tracking network for Multi-GNSS… *see M-GEX*

Real-Time Pilot Project

Example: ESOC RT Analysis Center

Last GPS Time = 2011/06/07 19:35:54.000   Current GPS Time = 2011/06/07 19:36:01.068
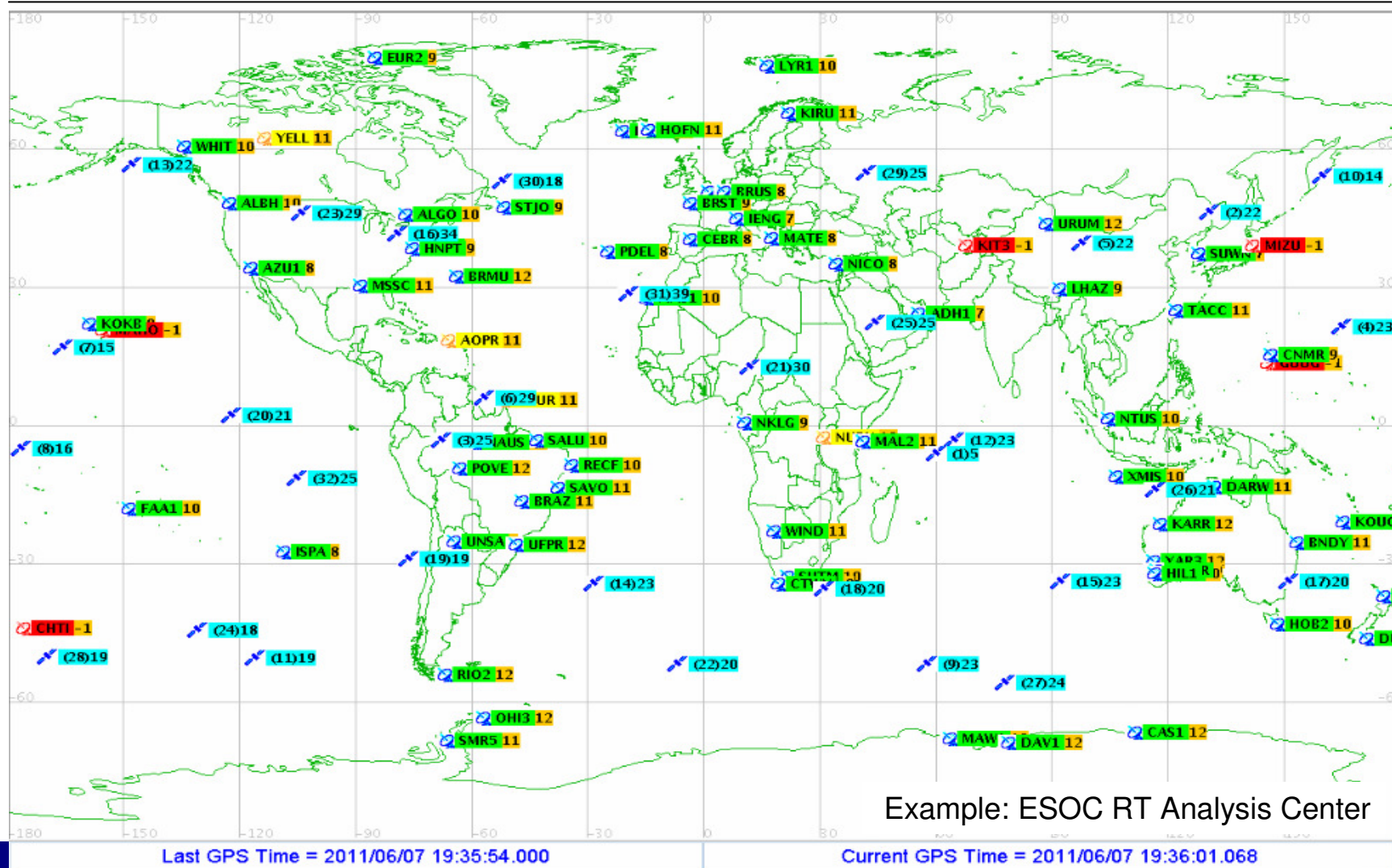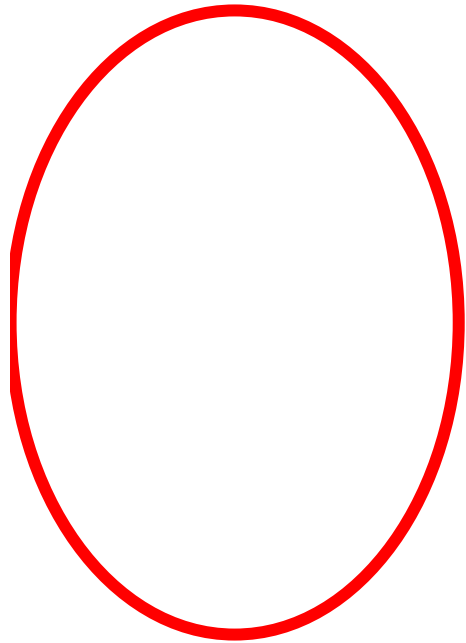
QuickTime™ and a
decompressor
are needed to see this picture.

M-GNSS: IGS Working Groups and Pilot Projects

Working Groups

Data Centre WG

Reference Frame WG

Tide Gauges WG

Space Vehicle Orbit Dynamics WG

Clock Product WG

Troposphere WG

Ionosphere WG

Antenna WG

Bias and Calibration WG

GNSS WG

RINEX WG

Real-Time PP

How to convert IGS network to Multi-GNSS?

Radiation pressure modelling for new satellites

Clock products for new signals

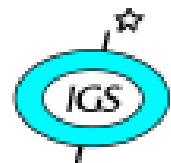Remote sensing

New systems and signals

patterns for new frequencies

biases of new signals

new systems (CfP)

observation format (RINEX 3.0)

Real-time products

Instrument Issues: Example of Galileo Signals

Galileo	E1	1575.42	A	PRS	C1A	L1A
			B I/NAV OS/CS/SoL		C1B	L1B
			C	no data	C1C	L1C
			B+C		C1X	L1X
			A+B+C		C1Z	L1Z
	E5a	1176.45	I	F/NAV OS	C5I	L5I
			Q	no data	C5Q	L5Q
			I+Q		C5X	L5X
	E5b	1207.140	I I/NAV OS/CS/SoL		C7I	L7I
			Q	no data	C7Q	L7Q
			I+Q		C7X	L7X
	E5 (E5a+E5b)	1191.795	I		C8I	L8I
			Q		C8Q	L8Q
			I+Q		C8X	L8X
	E6	1278.75	A	PRS	C6A	L6A
			B	C/NAV CS	C6B	L6B
			C	no data	C6C	L6C
			B+C		C6X	L6X
			A+B+C		C6Z	L6Z

Novatel 15A

JPS Delta-G2T

Septentrio GeNeRx1 *)

Leica GRX1200 GGPRO

*) depending on receiver configuration

RINEX 3.0x Observation File

```
 3.00                OBSERVATION DATA    M (Mixed)           RINEX VERSION / TYPE
NtripJPStoRnx         congo                    20101129 235945 GMT PGM / RUN BY / DATE
Source NTRIP stream 141.74.33.12/MAHO0                       COMMENT
MAHO0                                                        MARKER NAME
      M                                                      MARKER NUMBER
Hauschild             DLR/GSOC                               OBSERVER / AGENCY
Delta_00049           JAVAD TRE_G3TH DELTA 3.4.0a0_Q1        REC # / TYPE / VERS
09330045              LEIAR25.R3        LEIT                 ANT # / TYPE
 -5466067.0500 -2404333.4000  2242123.0100                  APPROX POSITION XYZ
          0.0000        0.0000        0.0000                 ANTENNA: DELTA H/E/N
G   20 C1C L1C D1C S1C C2X L2X D2X S2X C1W L1W D1W S1W C2W   SYS / # / OBS TYPES
       L2W D2W S2W C5X L5X D5X S5X                           SYS / # / OBS TYPES
R   16 C1C L1C D1C S1C C2C L2C D2C S2C C1P L1P D1P S1P C2P   SYS / # / OBS TYPES
       L2P D2P S2P                                           SYS / # / OBS TYPES
E    8 C1X L1X D1X S1X C5X L5X D5X S5X                       SYS / # / OBS TYPES
J   20 C1C L1C D1C S1C C1X L1X D1X S1X C1Z L1Z D1Z S1Z C2X   SYS / # / OBS TYPES
       L2X D2X S2X C5X L5X D5X S5X                           SYS / # / OBS TYPES
S    8 C1C L1C D1C S1C C5X L5X D5X S5X                       SYS / # / OBS TYPES
C..  12 C1? L1? D1? S1? C2? L2? D2? S2? C3? L3? D3? S3?      SYS / # / OBS TYPES
```

many new observation types

new systems
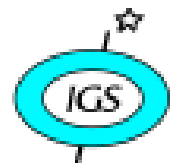
IGS CfP for Multi-GNSS Global Experiment

- Motivation:
  - New and modernised systems and signals upcoming (or available)
  - Receivers that have Multi-GNSS capabilities are available
  - IGS must prepare for incorporation of new GNSS measurements
- Goal:
  - Experiment to operate a global network of new receivers capable of tracking new signals in addition to GPS & GLONASS
  - Support JAXA's Multi-GNSS Monitor Network activities
- Tasks:
  - Set-up tracking network of Multi-GNSS receivers
  - Make tracking data files publicly available
  - Experiment with data flow, qualify equipment, signals, analysis...
  - *Upgrade IGS network to Multi-GNSS*
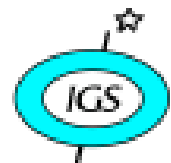 - *Generate Multi-GNSS products*
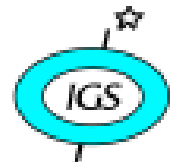
CfP for M-GEX

- Call-for-Participation issued… *http://igs.org/*
- Call for new stations:
  - Expansion of *continuous tracking network* according to IGS standards
  - Include other stations that may be more temporary or do not meet IGS standards that can enable *engineering* analysis of Multi-GNSS
  - Track as many signals as possible, focus on GNSS, but can include SBAS
  - The experiment is in parallel with ongoing IGS operations
  - Use COTS M-GNSS receivers… but SW receivers encouraged
  - RINEX 3.01 data format
  - Make tracking data publicly available through Data Centres
  - Real-time data streaming option to support RT-PP activities, and eventually production of RT products
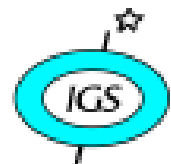
CfP for M-GEX

- Call for Data Centres:
  - Archive tracking data and make it publicly available
  - No interference to daily IGS operations

- Call for Collaboration with other federated networks to realise global M-GNSS network:
  - JAXA's MGM-Network, CONGO, ...

- Following steps:
  - Fill in gaps in site distribution and signal coverage
  - Not to disrupt the daily IGS operations
  - Include Real-Time tracking aspect and signal utilisation
  - Analysis of the new M-GNSS measurements to be conducted by IGS ACs on a 'best efforts' basis
  - Analysis and engineering analysis by other interested groups strongly encouraged

CfP for M-GEX

- Time schedule:

  - Early Aug 2011 - Call for Participation released

  - Oct 30, 2011 - Proposals due

  - Dec 15, 2011 – Proposals evaluated by the Organising Committee

  - Feb 1, 2012 – Experiment begins

  - Jul 23-27 – First results evaluation and discussion at IGS 2012 Workshop, Olsztyn, Poland

- Note: Interested organisations can join at any time.

- CfP also being circulated by GGOS soliciting proposals for a **core global network of multi-technique geodetic sites** to define and improve the Terrestrial Reference Frame and provide essential data for other space geodesy requirements, *including M-GNSS monitoring & IGS products*.
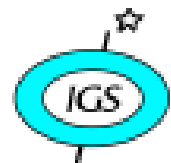
Concluding Remarks

- More than 100 GNSS satellites will be available in the near future.

- Not only more satellites, but also more and better signals, better clocks, etc.

- M-GNSS is vital for IAG/GGOS mission… *upgraded GGOS core infrastructure*.

- IGS is preparing for incorporation of new systems and signals into routine operations.

- CfP for IGS Multi-GNSS Global Experiment (IGS M-GEX) has been issued.

- Seeking groups that will track, archive, or analyse new signals.

- First results at IGS Workshop in Olsztyn, Poland, 23–27 July 2012.

- M-GEX can also provide raw data and/or products to support other (national or international) Multi-GNSS initiatives… *let's minimise duplication of global M-GNSS ground networks and ACs*.